49 Amphibian conservation and decline in Romania

Dan Cogălniceanu and Laurenţiu Rozylowicz

Abbreviations and acronyms used in the text and references:

asl	*above sea level*
EEC	*European Economic Community*
EU	*European Union*
IUCN	*International Union for the Conservation of Nature*
mtDNA	*mitochondrial deoxyribonucleic acid*
RL	*Red List*

I. Introduction

Romania is populated by 19 species, including a species complex of amphibians. The country comprises an area of 238,390 km^2 that is divided somewhat evenly between plains and meadows (33%), hills and plateaus (36%), and mountains (31%). It is positioned in the southeastern part of Central Europe and is bounded by the Carpathian Mountains, the lower course of the Danube (for a distance of 1,075 km), and the Black Sea. On a global land-based map, Romania is positioned at a latitude of 45°N and longitude of 25°E, encompassing a land area measured at 525 km north-south and 743 km east-west. The climate is temperate–continental, with multi-annual average temperatures of 8°C in the northern portion of the country, 11°C in the south, and a mean value of -2.5°C in the highest mountainous regions. Yearly precipitation decreases from west to east, from 600 mm in the Banat-Crişana Plain, to 500 mm in the Romanian Plain, and less than 400 mm along the coast of the Black Sea, while in the mountains annual precipitation reaches 1,000–1,400 mm (Rey *et al*. 2007).

Romania is situated at the junction of five different biogeographic regions (alpine, continental, pannonian, Black Sea, and steppic) out of the ten regions recognized by the European Union (EU). There are 17 major types of terrestrial ecosystem in Romania, including all of Europe's major ecosystems. These are designated as: boreal coniferous forests, mesophilous, hygrophilous,

xerothermic broadleaved forests, and various grasslands and shrubbery. Compared to the rest of Europe, Romania maintains a high proportion of natural and semi-natural ecosystems and habitats that cover 47% of the country, the rest being divided between agricultural land (45%) and built-up areas (8%) (National Institute of Statistics 2009). There is an abundance of semi-natural habitat created and maintained by low-intensity traditional farming (Cowell 2007). It is estimated that nearly 70% of Romania's territory was covered by forests two centuries ago, and approximately 50% of the area was still forested a century ago (Giurescu 1975). There are only four countries with intact forest landscapes currently left in Europe – the three countries of Fennoscandia (Norway, Sweden, and Finland) and Romania (Greenpeace 2006). Virgin forests in Romania cover 218,500 ha in parcels larger than 50 ha and represent 3.43% of the total forested area of Romania (Biriş and Veen 2005).

A. Human footprint

Romania has a relatively low population density of 90 inhabitants per km^2 (National Institute of Statistics 2009). The road network is moderately developed, with about 80,000 km of roads, of which 20% are national. Thus, it has the lowest road density (0.33 km/km^2) within the EU. The overall human impact is minimal due to a small human population density and an underdeveloped transportation highway network.

Historically, humans tended to settle along large rivers that provided water, food, shelter, construction materials, and transportation routes. For centuries these humans attempted to control flood levels and subsequent erosion to protect their settlements and agricultural fields (Gren *et al*. 1995). Many such massive environmental transformations were implemented along the length of the Danube River and its major tributaries, leading to the destruction of nearly 450,000 ha of wetlands linked to the river floodplain out of a total floodplain area of 540,000 ha (Schneider *et al*. 2008). The Danube Delta was also affected, with approximately 20% of the delta being dyked or drained (Ştiucă *et al*. 2002). Damming and dyking, combined with the development of a complex irrigation network constructed until the late 1980s in the southern part of Romania, promoted the dispersal of amphibians. During the 1990s, the overall irrigation network was de-emphasized and essentially dismantled (Davidescu *et al*. 2010).

B. Phylogeography

The present composition and distribution of Europe's fauna was shaped by glaciation. A number of studies, and the increasing body of accumulating data, have allowed for the identification of several general patterns. The highest genetic diversity in many species, and highest species diversity, is reported to be in the southern refugia, a region that has remained unaltered by these climatic changes. Genetic evidence of multiple range expansions and retractions during the Pliocene–Pleistocene climatic oscillations are still observable in southeastern and central Europe but are minimally detectable in northern Europe, thus generating the present pattern of northern purity and southern richness (e.g. Hewitt 2004).

Recent phylogenetic studies on amphibians point to multiple glacial refugia in Romania that contributed to the postglacial recolonization of central and northern Europe. The moor frog (*Rana arvalis*), being a lowland species, is restricted to humid habitats, with a broad Eurasian distribution. Babik *et al*. (2004) identified three main lineages in the Romanian Carpathian Basin. The balance of the species' range is populated by a single lineage, suggesting that the other two lineages, which harbour high mitochondrial and morphological diversity, survived several glacial cycles in the Carpathian Basin. However, they have not expanded to the North, at least not within this present interglacial period. A phylogenetic study of the spadefoot toad (*Pelobates fuscus*) identified nearly all genetic polymorphism in populations from the south of Romania and Serbia, considered as a

refugial zone (Eggert *et al*. 2006). Similarly, phylogenetic analysis of two newt species (*Lissotriton vulgaris* and *L. montandoni*) has shown that the older clades were found not only in the southern part of the range but also in central Europe (Babik *et al*. 2005). The Romanian lowlands, located northwest of the Black Sea, and the Carpathians are important refugial zones for *Bombina bombina* and *B. variegata,* respectively (Fijarczyk *et al*. 2011) and are far north of the Mediterranean areas usually regarded as glacial refugia, thereby highlighting the importance of these zones for ectothermic terrestrial species.

Table 49.1 The list and status of Romanian amphibians according to the European Union Habitats Directive and Bern Convention annexes and three different Red Lists.

Taxon	Habitats Directive	Bern Convention	IUCN Red List Europe (2009)[1]	IUCN Red List Europe 27 (2009)[1]	Romanian Red List (2005)[2]
Triturus dobrogicus	3	2	NT	NT	EN
Triturus cristatus	3, 4A	2	LC	LC	VU
Lissotriton vulgaris	4B	3	LC	LC	NT
Lissotriton vulgaris ampelensis	3, 4A	3			VU
Lissotriton montandoni	3, 4A	2	LC	LC	VU
Ichthyosaura alpestris	4B	3	LC	LC	VU
Salamandra salamandra	4B	3	LC	LC	VU
Bombina bombina	3, 4A	2	LC	LC	NT
Bombina variegata	3, 4A	2	LC	LC	NT
Pelobates fuscus	3, 4A	2	LC	LC	VU
Pelobates syriacus	4A	2	LC	NT	EN
Bufo bufo	4B	3	LC	LC	NT
Bufotes viridis	4A	2	LC	LC	NT
Hyla arborea	4A	2	LC	LC	NT
Rana dalmatina	4A	2	LC	LC	VU
Rana temporaria	4B, 5A	3	LC	LC	VU
Rana arvalis	4A	2	LC	LC	EN
Pelophylax kl. *esculentus*	5A	3	LC	LC	
Pelophylax lessonae	4B	3	LC	LC	
Pelophylax ridibundus	5A	3	LC	LC	

1 Temple and Cox (2009).
2 Iftime (2005).

II. Species of special conservation concern

A. Taxonomic issues

Of the 19 species of amphibians in Romania, 7 (*Lissotriton vulgaris, L. montandoni, Ichthyosaura alpestris, Bufotes viridis, Pelophylax ridibundus, P. lessonae*, and *P.* kl. e*sculentus*) have been affected by recent taxonomic changes (Cogălniceanu *et al*. 2013). The changes are not currently included in legislation, thus generating an inconsistency among managers, decision-makers, and taxonomists (Table 49.1). The nomenclature used in the present chapter is according to Speybroeck *et al*. (2010). There is uncertainty regarding the specific taxonomic status of *Triturus dobrogicus* after Litvinciuk and Borkin (2000) described two subspecies without precise range boundaries in Romania, a study unconfirmed later by Vörös and Arntzen (2010). Also, the presence of *T. arntzeni* (now *T. ivanbureschi*) indicated by a map in Vörös and Arntzen (2010) has not been confirmed.

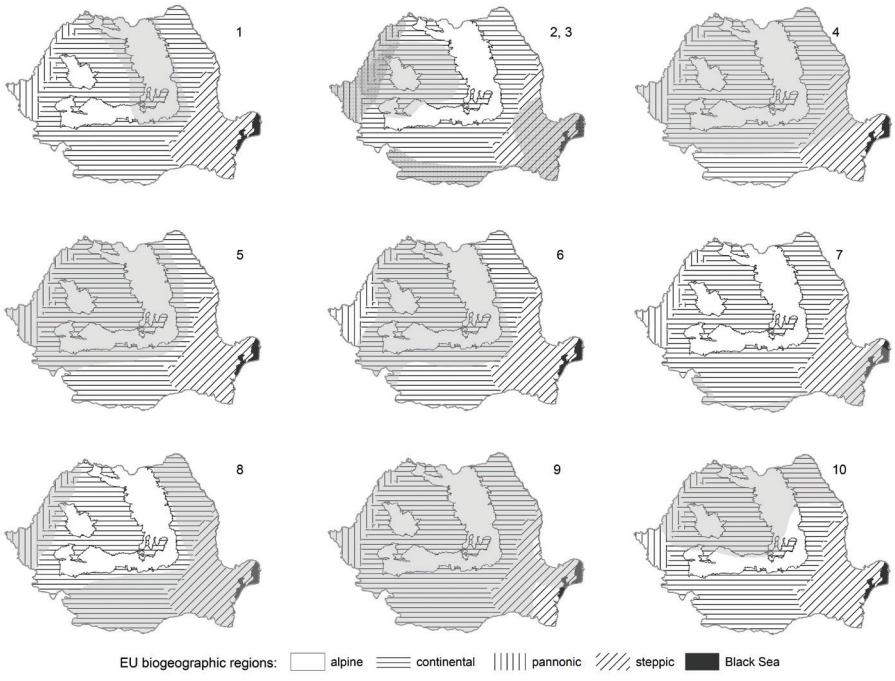

Fig. 49.1 The Romanian distribution of the amphibian species that reach their distributional limits within that country (grey areas) in relation to the distribution of the European Union's Biogeographic regions there (see code). 1: *Lissotriton montandoni*; 2: *Triturus dobrogicus* – stippled gray range; 3: *Lissotriton vulgaris ampelensis*; 4: *Triturus cristatus*; 5: *Salamandra salamandra*; 6: *Bombina variegata*; 7: *Pelobates syriacus*; 8: *Pelobates fuscus*; 9: *Rana dalmatina*; 10: *Rana arvalis*.

More than half of the species found in Romania are at the limit of their geographic range and are of special importance for conservation (Cogălniceanu *et al.* 2013). Of these, five have a range restricted to a certain area or type of habitat (Popescu *et al*. 2013) (Table 49.2; Figure 49.1).

B. Hybridization

Three pairs of related species hybridize extensively in Romania, the extent of the area of hybridization possibly having been increased by human-induced changes in their habitat. The two species of toads of the genus *Bombina* hybridize extensively (Szymura 1993). The pattern of the hybrid zones differs in Romania, either clinal (i.e. narrow contact zones) in the south and east, or extended mosaic hybrid zones in Transylvania (Vines *et al*. 2003). The two related small species of newt, *Lissotriton vulgaris* and *L. montandoni*, hybridize extensively within their areas of contact, usually at elevations of 500–1,000 m asl (e.g. Fuhn *et al*. 1975). A recent molecular study by Babik *et al*. (2005) reported a replacement of the original *L. montandoni* mtDNA by *L. vulgaris* mtDNA. This was most likely facilitated by reduction of the effective population size of *L. montandoni* in refugia during glacial periods. The two species of crested newts (*Triturus cristatus* and *T. dobrogicus*) also hybridize along narrow contact zones, the latter species being restricted to floodplains (Cogălniceanu *et al*. 2013).

Table 49.2 Amphibian species that reach the limits of their distributional range in Romania.

No.	Species	Limit of Distributional Range	Range Size
1	*Lissotriton montandoni*	Eastern and southern limit	Restricted
2	*Triturus dobrogicus*	Eastern limit	Restricted
3	*Lissotriton vulgaris ampelensis*	Endemic subspecies	Restricted
4	*Triturus cristatus*	Southern limit	Widespread
5	*Salamandra salamandra*	Eastern limit	Widespread
6	*Bombina variegata*	Eastern limit	Widespread
7	*Pelobates syriacus*	Northern limit	Restricted
8	*Pelobates fuscus*	Southern limit of contiguous range	Widespread
9	*Rana dalmatina*	Eastern limit	Widespread
10	*Rana arvalis*	Southern limit	Restricted

C. Major threats

A recent evaluation has revealed major threats to amphibians in the Palaearctic region (Anthony *et al*. 2008). In their order of significance these are: habitat loss, land use changes, pollution, natural disasters, human disturbance, invasive species, accidental mortality, fire, and disease. Of these, habitat loss, pollution, and accidental mortality have been documented for Romanian amphibians. While industrial pollution has decreased over the past two decades, intensification of agriculture and ongoing improper treatment of wastewater are escalating (Patroescu *et al*. 2006) and both pose serious threats to lowland species (e.g. *Triturus dobrogicus*; *Bombina bombina*).

The species in Romania that are most affected by habitat destruction are the habitat specialists: *Rana arvalis, Pelobates* sp., and *Triturus dobrogicus*. The moor frog *Rana arvalis* is widely distributed throughout Europe and considered of least concern, but its range is steadily decreasing. Roček and Sandera (2008) suggested that increased previous deforestation in Europe restricted its range to floodplains along rivers. This species is now severely threatened by habitat destruction as a result of damming and dyking and has already vanished from several localities (Sas *et al*. 2008).

The two species of the genus *Pelobates* reach their ranges' limits in Romania. The present-day range of *P. syriacus* seems to be much smaller than before. During the Pliocene era its range extended much farther north, into Central Europe. The fragmentation of the previously contiguous range within the Balkans limited its distribution to a few restricted refugial zones (Ugurtaş *et al*. 2002). Fossils of *P. fuscus* have been identified from the Middle Miocene onward within Central Europe (Venczel 1999). The last post-glacial invasion into central Europe occurred from southern Europe, a long-standing refugial zone (Eggert *et al*. 2006). Both species have faced a reduction in their range in the Balkans during the past century (Džukić *et al*. 2005). The range of *P. syriacus* has also undergone a recent contraction (Delfino *et al*. 2007), while *P. fuscus* is vanishing within Sweden (Nystrom *et al*. 2002) and Denmark (Fog *et al*. 1997). A recent study of the genetic diversity of *P. syriacus* in Israel (at the southern limit of its range) exposed an increase in genetic variability from the core of its range to the edge of its dispersal. This finding is explained by the much harsher climatic and abiotic conditions at the range's edge, which must be tolerated over generations both by tadpoles and by post-metamorphic individuals in that region (Munwes *et al*. 2010). This result demonstrates the high conservation value of populations at the limits of their ranges.

III. Conservation measures and monitoring programmes

A. Legislation and conservation policy

Conservation within the EU member states is based on several conventions and directives: the Convention on Biological Diversity, the Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats, 1979), the Bonn Convention (Convention on Migratory Species, 1979), and the two directives: Birds, adopted in 1979 (Council Directive 79/409/EEC on the Conservation of wild birds), and Habitats, adopted in 1992 (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora) (Pullin *et al*. 2009). At national levels, the conservation priorities are based on the annexes of protected species in the EU Directives and Conventions, as well as on a number of Red Lists.

The percentage of protected areas in Romania has increased almost five times since 1989, from 4.1% to 19.29% of the national territory. These increases were the result of the creation of 27 National and Natural Parks and 382 protected areas as part of the EU Natura 2000 network (Iojă *et al*. 2010). A similar trend of rapid increases of protected areas worldwide has raised concerns about the capacity to manage them (Sutherland *et al*. 2009). The same applies to Romania, as well, where the efficiency of the extended network of protected areas is criticized as being comprised of unclear conservation goals and with a focus on protecting species and habitats of European-level concern (Iojă *et al*. 2010). The Birds and Habitats Directives originated from EU 12, and the lists of priority species and habitats from the annexes reflect the situation at the moment. The annexes were updated after each new expansion (in 1995, EU 15 when Finland, Austria, and Sweden joined the EU; EU 25, when 8 former communist countries, Malta, and Cyprus joined in 2004; and finally EU 27 in 2007 when Romania and Bulgaria joined). New species were added to the annexes, but never re-evaluated on the basis of their status in the enlarged EU. Thus, many amphibian species endangered in Western Europe are still common in central and southeastern Europe (e.g. *Bombina* spp.). The present priorities are European priorities, at a continental level. National priorities that are relevant at regional and local levels are still required in addition to the EU priorities. A critical reappraisal of priorities at both EU and national levels is proposed. This would involve up-scaling or down-scaling in priorities of species listed in the annexes, or in establishing targeted priorities at local and provincial levels.

Monitoring is a requirement for Natura 2000 sites and must be conducted within each site by the administrator of that site. There are no standardized protocols and the results of the ongoing surveys do not allow detection of trends in population size. Long-term monitoring studies on amphibian populations and their habitats are carried out in central Romania (e.g. Hartel *et al*. 2010, 2011).

B. Red Lists

In addition to the above-listed legislation, there is a wide range of Red Lists (RL) at global, European, regional (e.g. Witkowski *et al*. 2003), national, and local levels (Köppel *et al*. 2003). Many European countries still use different criteria in establishing National Red Lists (De Iongh and Bal 2007). While global and regional RL are constructed according to strict rules and criteria, national, and local RLs are prepared inadequately and mostly reflect the author's opinion or bias, without criteria or even reasons given. As an example, the Romanian national RL (e.g. Botnariuc and Tatole 2005) and local RL (e.g. Oţel and Ciocarlan 2000) use only 9 categories while the IUCN recommends the use of 11 categories for regional assessments. These shortcomings limit the value and utility of national RLs that should be considered with caution for they do not allow further analyses or the detection of trends. Szekely *et al*. (2009) compared several national and regional RLs, with a focus on the Black Sea province of Dobrogea. Considerable differences were observed between the Red

Lists, not only in the use of subjective rather than objective criteria, but also by different spatial scales, with some species locally abundant and others regionally rare or with a restricted distribution. Overall, many European countries still use different criteria in establishing national RLs (De Iongh and Bal 2007), thus requiring their harmonization within Europe. There are also significant differences in the conservation status of species listed within the various conventions, directives, and RLs (e.g. Batáry *et al*. 2007).

C. Conservation and taxonomy

Over the past few decades, major changes have developed in the taxonomy and systematics of amphibians, with the number of recognized species of amphibians increasing 48.2% since 1985 (Frost *et al*. 2006). Most recent descriptions are new discoveries, while removal from synonymy represents only a small proportion (14%) of the newly recognized species (Köhler *et al*. 2008). Apart from the increasing rate of species description, there are major nomenclatural changes in amphibian taxonomy (e.g. Frost *et al*. 2006), and more changes are likely in the future. This shift is partly due to the major technological advances and to the increasing number of specialists worldwide that work on amphibians. The increasing number of herpetologists and their resulting publications is illustrated by the increase in the output of literature: 25% of all the publications on amphibians published were released during the past decade. This in turn has created a "herpetologist effect", similar to the "botanist effect" (e.g. Pautasso and McKinney 2007), whereby more amphibian specialists result in increased sampling and in the recognition and description of new species. The significant increase in described species does not have a direct impact on Romania's amphibians, since most newly described species are tropical (Cogălniceanu and Hartel 2009).

A prolonged period of time is required to include taxonomic changes in legislation, which illustrates the slow process of assimilating new approaches and research findings into the management of biodiversity (Cogălniceanu and Cogălniceanu 2010). Thus, conservation is frequently hampered and delayed by taxonomic instability that makes regional and international cooperation difficult due to misunderstandings concerning the names of priority species (Isaac *et al*. 2004).

D. Conservation strategies

The EU Habitats and Birds Directives are focused on favourable conditions for conservation. While overall management plans have to be tailored according to the species of conservation concern and to the specific conditions existing in the area, there are some broad generalities. Species that require particular protective measures can be included in two broad categories:

1. Species abundant in the past but now under threat from human activities such as habitat destruction and over-harvesting (e.g. *Rana dalmatina*; *R. temporaria*; *Lissotriton vulgaris*; *Triturus cristatus*; *Hyla arborea*; *Bufo bufo*). A ban on harvesting brown frogs for meat (frog legs) and the creation of ponds for reproduction are sufficient measures in the medium-term.
2. Species that were rare in the past, or which have a small or fragmented range and low densities and population sizes, caused either by superior competitors, effective predators, or specific habitat requirements (e.g. *Rana arvalis; Pelobates syriacus*; *Triturus dobrogicus*; *Lissotriton montandoni*). These species require more complex and active measures involving the preservation of their habitats, eliminating fish from some areas, providing migration corridors, while constantly monitoring their populations for change.

Additional studies on habitat use and population status of Romanian amphibians are required since Romania is extremely heterogeneous (e.g. covering five biogeographic regions), and has human impacts that vary regionally.

IV. Conclusions

The EU Common Agricultural Policy has triggered important socio-economic changes of traditional land use (Young *et al*. 2007). Many traditional land-use systems are presently affected either by abandonment of land or intensification of its use (Plieninger *et al*. 2006; Kuemmerle *et al*. 2009). After 1990, the use of pesticides and chemical fertilizers decreased steadily (Turnok 1996; Ciaian and Pokrivcak 2007), but an increase in their use is foreseeable in connection with the intensification of agricultural practices. The number of temporary ponds along dirt roads and of artificially-made aquatic habitats used for watering cattle is declining due to improved management and infrastructure of roads, and the spread of modern watering systems. The stocking of bodies of water with fish also has recently resumed and has resulted in the exclusion of amphibians from many habitats for breeding (e.g. Hartel *et al*. 2007). Despite the low density of roads, a steady increase in intensity of vehicular traffic has triggered higher death rates along roads and thereby contributes to fragmentation and isolation of habitats. The presence of the chytrid fungus was recently reported from Romania (Vörös *et al.* 2013), but no harmful effects were found in the populations studied. Overall, the conservation measures currently in place in Romania might not prevent or even reduce the expected decline in amphibians; more specific measures are required, targeted at preserving and managing aquatic habitats used for breeding.

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